Overcoming heterogeneity in Spatial Data Infrastructures (SDIs)

Importance, elements, solutions and progress

Integrating between Geo-data bases to provide Geo-services through an internet environment is becoming main interest for many users in different sectors: government agencies, business firms and researchers, This various users concern rises from recent and crucial global phenomena of environmental changes, hazards and disasters which is significantly effecting our lives and even more(in some cases)our own survival. This users rising concern becomes more acceptable if we put in mind that these environmental hazards are a result of human activities in over exploiting earth natural sources and continuance polluting of earth seas and atmosphere. Connecting and integrating geographical data bases (GIS servers) from different countries in one virtual system e.g. webpage interface ,where users can explore, request and retrieve geo-data will certainly benefit in changing communities behaviors and improving their awareness for environmental risks ,especially when officials and citizens can visualize environment hazards and fallow their impacts in different part of the world with realizing how their regional environments are affected by these impacts .

Many initiatives and studies have been done to form principles (or more accurately frameworks) for combining different Geo-data bases and overcoming interoperability problems during this integrating of heterogeneous geographical data bases and systems, most of these initiatives and studies intend to summarize Geo-data integration problems to three factors of heterogeneity that's can hinder SDIs interoperability establishing :

Syntactics factor: results from integrating different data bases that uses different data formats which forces operators to perform several data format conversion operations to achieve one unified data format between two or more data sets .

Structural factor: results from integrating Geo-systems that uses different schemas to structure their data sets, the schemas are often combined from hierarchical structure (classes containing objects and objects formed from features) and varies from information system to another which results in complexity of data shearing and exchange, e.g. an object formed from many features in one data set can be considered as one feature object in another data set.

Semantics factor: result when using different terminologies when referring to same data sets objects and features , which is a common case between any two different data sets, e.g. similar features in two data sets have different names or different features in two data sets have the same term.

For solving these heterogeneity factors in geographical systems many approaches and solutions are provided, most of these approaches depend on software technology (plug in applications) when solving syntactic problems, especially for performing data conversion and format transformation. For solving structural problems, approaches based on web services are used to perform automated data exploring and analyzing to determine and retrieve the similarity between structural elements of different data set (depending on metadata). Using Ontology principles are one of the approaches used for solving semantic heterogeneity; Ontology provides references in determining meanings of used terms, especially if these terms are used in referring to geographical objects or features in Geo-data sets, which facilitates the combination of two different features from different data sets depending on their used terms. However, even with these promising approaches and solutions (which already are applied by different levels of geographical data specialist) for solving and overcoming SDIs heterogeneity the fact remains that it's still a complicated process and we are still at the beginning of a long way for solving SDIs heterogeneity problems and reaching an optimum solution for geographical data integrating and geo services combining , a major aspect in reaching such optimized solution , is to minimized manual operations performed by users to receive requested information, meaning the ability to automate the processes of exploring , combining and visualizing geographic data from different data bases in one harmonized data interface(e.g. map).One of the approaches in this direction is the OGC proposed standard for GIS data owners and producers which is in general focusing on unifying data format between different data producers to facilitate the processes of automated search for Geo-data and Geo-services , automated integration between Geo-data sets and automated Geo information visualization . unfortunately (as mentioned before) even with these recommendation from OGS ,the process of obtaining interoperability between different GIS systems is still complicated and under development, it still needs more efforts from developers and researchers to overcome farther aspects of interoperability issues than the typical heterogeneous elements , aspects related to data capacity when dealing with satellite images, or with data limitation of access when requiring data for restricted region e.g. area with military activities , or in cases of trying to combine geographical systems that uses different languages, how to identify similarity between objects in both system? and in which language the resultant map should be? Going more in depth in the heterogeneity aspects we face problems related to hardware with the use of different processing and display unites (laptops, smart phones) from user side which brings another level of difficulties that demands more developing to bring out applications and interfaces suitable for users devices.

In conclusion , handling heterogeneity in SDIs and proposing efficient solution to insure interoperability between Geo-data sets needs more focusing in discovering ,analyzing and modeling various aspects and elements causing heterogeneity, it's certainly needs more investments from developer and researchers in gaining more insight of heterogeneity elements which exceeded conceptual elements of harmonized data structure or similarity of data format and terminology to solving more practical elements of heterogeneity related to user side needs and demands from an integrated SDIs systems (which is what the final submitting of this paper will focus on) all in seek of providing users with complete , optimum and user-friendly services that combined Geo-services and Geo-information's in one virtual system .

References:

1. A geo-service semantic integration in Spatial Data Infrastructures.
Lorenzino Vaccari1, Pavel Shvaiko and Maurizio Marchese
Dipartimento di Ingegneria e Scienza dell'Informazione,
University of Trento, Italy
2. Development of an interoperable tool to facilitate spatial data
integration in the context of SDI
Hossein Mohammadi, Abbas Rajabifard* and Ian P. Williamson
Department of Geomatics, Centre for Spatial Data Infrastructure and Land
Administration,University of Melbourne, Victoria, Australia
3. Issues of Multilinguality in creating a European SDI –the perspective for spatial data
Interoperability Joanna Nowak, Javier Nogueras-Iso, Stephen Peedell
Institute for Environment and Sustainability, Joint Research Centre
4. Geospatial data sharing based on geospatial semantic web technologies
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a Department of Geography, Kent State University, Kent, Ohio
5. Overcoming Differences of Meaning in Spatial Data Infrastructures –
Achievements and Challenges1
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6. Overcoming semantic heterogeneity inspatial data infrastructures
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